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CHAPTER 10. Facilities Maintenance Standards and Actions

10.1. Introduction

Maintenance standards provide the basic information that identifies what portions of the inventory receive maintenance and to what level they are to be maintained. They also provide the benchmarks for conducting condition assessments and estimating workload. This chapter discusses maintenance standards in detail. Chapter 3 paragraph 3.12, Management Analysis, discusses the use of metrics and benchmarking in setting and updating maintenance standards.

10.2. Facilities Maintenance Standards

10.2.1. Centers should use generally accepted facilities maintenance standards, as detailed in this procedures guide and the references contained in Appendix B, appropriate for the NASA objective of providing facilities to support safe, "world class" research and operations. The standards, which form a part of the PM programming, should be the basis for evaluating the condition of the facilities and for determining the minimum and desired material condition of facilities and collateral equipment. Centers should develop and use maintenance cycles that take into account the level of local use and environmental conditions.

10.2.2. In addition to the facilities maintenance standards used to identify deficiencies not visually discernable and those outlined in Appendix B, the following types of deficiencies would not normally be expected to be found at a Center with a sound facilities maintenance program:

a. Peeling or flaking paint.

b. Rust stains or corrosion.

c. Stained or mildewed concrete surfaces.

d. Leaking roofs.

e. Leaking pump seals.

f. Failed asphalt or concrete paving.

g. Debris on grounds or in mechanical areas.

h. Spalled or scaling concrete.

i. Tripping hazards.

j. Leaking steam traps.

k. Stained or broken ceiling tile.

l. Worn or broken floor tile.

m. Painted surfaces worn through to base materials.

n. Carpet wear paths or ripples.

o. Electrical or mechanical equipment not meeting current codes.

p. Unsecured or failed pipe insulation.

q. Overheated motors or other electrical devices.

r. Abandoned-in-place conduit and cables (unless facility is to be excessed).

s. Traffic signs and markings not meeting the Manual on Uniform Traffic Control Devices.

t. Faded or illegible building signs.

u. Leaking and nonoperational components.

v. Broken or cracked windows.

w. Permanent electrical extension cords.

10.2.3. As a general rule, Centers should have appropriate landscaping, color-coded and identified piping, efficient and reliable heating and air conditioning equipment, and other amenities suitable for facilities to support the safe, "world class" research and operations that are NASA's goal.

10.2.4. Centers should use maintenance standards, conduct periodic condition assessments of their facilities against the maintenance standards, and determine and carry out the maintenance actions required to meet the standards. In order to set the standards and accomplish these actions, Maintenance Support Information (MSI) must be collected. This chapter provides suggested methods to collect the MSI and then develop and implement maintenance standards, continuous inspections, condition assessments, and maintenance actions. By using the following, a facilities maintenance organization can maximize its capabilities:

a. Following standards.

b. Using good planning and estimating practices.

c. Accurately recording work accomplishments.

d. Analyzing internal work through metrics and benchmarking.

e. Accepting improvement changes.

10.3. Facilities Condition Standards

a. A maintenance standard is the expected condition or degree of usefulness of a facility or equipment item. It is often a statement of the desired condition or a minimum acceptable condition beyond which the facility or equipment is unsatisfactory. Maintenance standards should be applied not only when inspecting facilities and equipment currently on hand but also when specifying or accepting facilities and equipment being procured or installed.

b. Recorded facility or equipment conditions may vary based on the perspective of the individual inspector. Therefore, clear, unambiguous standards are necessary to ensure that there is consistency in the inspection results obtained by the individuals performing the inspections.

10.3.1. Types

10.3.1.1. Facilities condition standards may take many forms. The following are some examples:

a. Error or leakage rate.

b. Wear (e.g., remaining tire tread).

c. Elapsed time since last overhaul.

d. Chemical composition.

e. Vibration level.

f. Availability.

g. Maximum allowable deflection.

h. Operating temperature.

10.3.1.2. The applicable standard depends on the item, its intended use, and the mission criticality or health and safety aspects of that use. Thus, identical items can have different standards when used for different applications. Maintenance standards provide benchmarks for FCAs, PT&I, PM, operator inspection, and determination of maintenance requirements.

10.3.2. Sources

10.3.2.1. There are many sources of maintenance standards, each with different force, effect, and applicability. Appendix B contains a list of publications that provide information on maintenance standards. Some cover specific types of facilities and equipment; others are more general. Common sources are as follows:

a. Laws and regulations.

b. Manufacturers or vendors.

c. Trade or industry associations.

d. Government publications.

e. Locally developed standards.

f. Specialized standards.

g. Energy consumption.

10.3.2.2. The MSI discussed in paragraph 10.9, Maintenance Support Information (MSI), contains much of the information necessary to develop the condition or performance standards for facilities and installed equipment. This information is then evaluated against legal requirements, regulations, industry standards, intended use, and mission supporting requirements to determine the applicable maintenance standard for the item.

10.3.3. Setting Standards

10.3.3.1. Existing Facilities

a. Normal practice is to set standards while establishing a maintenance program for a facility or equipment item. The source of the standard used is that which best covers the operational use of the facility or equipment. Where individualized standards are necessary, knowledgeable operations and maintenance personnel should work together with reliability engineers, where applicable, to develop and document an appropriate standard.

b. Care should be taken when developing a local standard. Many existing standards, often 25 to 30 years old, do not reflect recent changes in technology; consequently, they may be inadequate, typically addressing only very general or minimal performance criteria.

c. Paragraph 10.9, Maintenance Support Information (MSI), discusses the process of collecting MSI to support standards development.

10.3.3.2. New Facilities and Equipment. Historically, the vendor or construction/ installation contractor has been the source of maintenance standards and related information (including maintenance procedures) for new facilities and equipment. An alternative is to develop facilities MSI for the new facility or equipment as part of the design process. In fact, this is one of the primary functions of a proactive maintenance program, which bases the specifications for new facilities and equipment on such maintenance-related information as facility and equipment history, reliability, and life-cycle cost data obtained from maintaining and operating the equipment and facilities being replaced.

10.3.3.3. Methods of Setting Standards

a. Due to the unique nature of certain NASA facilities, existing maintenance standards or requirements may be inappropriate. As a result, it may be difficult to develop a comprehensive and efficient maintenance plan for an individual item. In any case, however, standards can be researched and developed by Centers, either in house or by an Architect and Engineering (A&E) contractor, as described in paragraphs 10.4, Work Performance Standards, and 10.9, Maintenance Support Information (MSI).

b. Standards should be tailored to the specific needs and missions of the Center. One philosophy used in setting and using standards is described in Chapter 7, Reliability Centered Maintenance.

10.4. Work Performance Standards

a. Standards of work for specific tasks are necessary to plan work properly, to evaluate the quality of the work performed, and to evaluate the efficiency of the work control process. This is particularly important in the case of maintenance work because most of the work orders are relatively small compared to major repair work. Additionally, the jobs are normally spread out over a large area. When uncontrolled, typical maintenance work can involve an extensive amount of travel time as compared with work performance time. Repetitive jobs, in particular, should be evaluated with respect to applicable standards and reviewed for possible improvements in efficiency.

b. Preventive Maintenance is a primary example of repetitive work, typically with similar tasks performed on many items of equipment in many different locations. A well-designed PM program incorporates standard time estimates. Actual performance times are recorded for subsequent evaluation and for reference when planning and scheduling future PM cycles. A facilities maintenance manager can evaluate the effectiveness of a PM crew by the amount of time expended on a job versus the standard time. Further, the manager can look for trends as explained in Chapter 3, Facilities Maintenance Management.

10.4.1. Maintenance Work Standards

10.4.1.1. The construction industry has developed work standards primarily for cost estimating. Commercial bids are tracked, and the associated cost and time estimates are analyzed and used to publish construction industry standards. Some of these construction cost and time standards can be applied to maintenance work, principally to larger projects such as the replacement of major items.

10.4.1.2. This data is updated and published annually for use in estimating, budgeting, and planning maintenance work on a per-project or annual basis. These publications cover areas such as maintenance and repair task, time, and cost data; PM task, time and cost data; equipment rental costs; city cost indexes; historical cost indexes; audit information; and life-cycle costing. These standardized task descriptions, times, and costs are developed for both in-house workforces and contractor operations. This or similar data can be used along with local data to develop initial maintenance work orders that can be updated with experience. (See Appendix B for a list of these publications.)

10.4.2. Engineered Performance Standards (EPS)

10.4.2.1. EPS are a comprehensive tool for planning and estimating facilities maintenance and related facilities work. They provide methodology and a series of standard maintenance tasks and task times, which are combined to develop a work order plan and work order estimate. The system builds the estimate by aggregating the incremental times for tasks and adding time allowances for setup, cleanup, travel time, and local factors. EPS can be applied manually or by computer.

10.4.2.2. The work order plans and estimates that EPS produces are consistent and repeatable, and thus provide good benchmarks for planning work and evaluating performance. EPS estimates are based on average crafts personnel working with proper tools under average conditions. A well-qualified crew will beat the EPS estimate consistently, and an inexperienced crew is likely to lag the EPS estimate.

10.4.2.3. Publications are available to provide detailed EPS guides. (See Appendix B for a list of those publications.) A computerized version of EPS is also available.

10.4.3. Local Standards. Local experience documented in maintenance history files is a valuable source of information for work order planning and estimating and may be used as a basis for standards. However, actual maintenance tasks and performance times for past work should be spot checked against standards to ensure that the times are reasonable and work practices are efficient, effective, and in line with current codes, standards, and technology. A major value of a CMMS is to provide completed work information to validate the appropriateness of the standards used and to help tailor them to local conditions.

10.4.4. Other Standards. A variety of facilities cost estimating standards is available. Many are focused on new construction, renovation, or facilities repair tasks; however, they can be useful in estimating maintenance work, especially work that is similar to construction, provided adjustments are made for job scope. One example of this is SPECSINTACT, as managed by the Director, Facilities Engineering Division, NASA Headquarters.

10.4.5. Reliability Centered Maintenance (RCM). Critical to RCM are the design, construction, acceptance, and performance standards associated with equipment and the various PT&I technologies. Chapter 7, Reliability Centered Maintenance, in this guide, the NASA Facilities RCM Guide, and the NASA Facilities and Equipment Acceptance Guide all discuss standards in detail and provide acceptable ranges for performance. Equipment approaching the limits of or operating outside of the acceptable range are candidates for remedial action.

10.4.6. Reliability Centered Building and Equipment Acceptance

Centers should employ equipment acceptance standards, an element of the facility and equipment acceptance process, and noninvasive diagnostic tests that verify systems and equipment condition and installation prior to the exit of the installing contractor from the job site. The purpose of the standards and testing is to verify that the system performs according to design intent with no latent manufacturing or installation defects, is less costly to maintain, and meets the required operational efficiencies. Facilities and equipment commissioning and acceptance is discussed in Chapter 8, Reliability Centered Building and Equipment Acceptance.

10.5. Continuous Inspection

Inspections are the cornerstone of facilities maintenance management. They identify needed maintenance work, provide feedback on the effectiveness of the facilities maintenance program, and form the basis for changes to the program. NASA Centers are required to continuously assess facility conditions in a manner that results in the identification and quantification (in terms of dollars) of a BMAR that is 80-percent accurate at any point in time.

10.5.1. General Inspection Requirements

10.5.1.1. During an inspection, if the inspector uncovers unsafe conditions, the inspector shall notify the individual in charge of the operation and determine whether people and/or property are at imminent danger. If so, there should be a strong consideration by the operator to cease operations until corrective action is taken. The Center's safety office should be notified of the situation as soon as practical.

10.5.1.2. Safety is recognized as a leading value in the maintenance process and therefore an important part of the inspection program. Facility and equipment deficiencies identified in the Continuous Inspection Program will be evaluated for failure and failure consequences (risk assessment) to identify safety impacts. When the evaluation identifies a safety impact (hazard to personnel or NASA property) the Center's safety office must be notified and appropriate action must be taken to alleviate the hazard.

10.5.1.3. Centers should develop a procedure for performing and documenting risk assessments of deficiencies identified in the Continuous Inspection Program, for notifying the Center's safety office of any safety deficiencies, and for assuring the deficiencies are made safe.

10.5.2. Inspection Types. A Center's continuous inspection program should include the following:

10.5.2.1. PT&I. PT&I uses advanced technology to sense building, electrical equipment, and machinery operating characteristics such as vibration spectra, temperature, noise, and pressure and to compare the measured values of these characteristics with historical data or other preestablished criteria to assess the items condition. PT&I permits condition-based rather than time-based initiation of the maintenance effort to correct any problems identified. Evaluation of the PT&I data can be used to project future maintenance requirements for inclusion in the AWP or 5-year Plan. See Chapter 7, Reliability Centered Maintenance, for additional information about PT&I.

10.5.2.2. Preventive Maintenance (PM). Inspections are a major part of Preventive Maintenance and are performed on a time- or other interval-based schedule, normally using prespecified checklist items. These inspections may include minor adjustments and minor repairs (no larger in scope than TC) of equipment included in a PM program. The inspection results should include a condition assessment documented in the Center's CMMS for use in projecting future maintenance requirements. PM's typically cover untended equipment.

10.5.2.3. Operator Inspections. Operator Inspections are the examinations, lubrication, minor repairs (no larger in scope than TC's), and adjustments of equipment and systems that have an operator assigned. Typically, they apply to equipment or systems such as those in a central utility plant. Operators should provide condition assessments for documentation in the CMMS.

10.5.2.4. Facility Manager Inspection. Periodic inspection should be performed by the Facility Manager. This inspection should include common spaces, hallways, equipment rooms, roofs, and grounds and other areas not covered by individual facility users. Users of private spaces, such as offices, should be evaluated as described in paragraph 10.5.2.5, Facility User Inspection. The Facility Manager should document the facility condition on at least a semi-annual basis.

10.5.2.5. Facility User Inspection. The Facility User should be surveyed on a semiannual basis for the user's inspection input that could be made on a form such as shown in Figure 10-1. This is in addition to the Facility Manager's inspection. Figure 10-2. should be printed back-to-back with the Figure 10-1 Form to ensure the Facility User's input can be coded into the CMMS for data integration and analysis.

Figure 10-1. Facility User Inspection

Circle a number from the two most left columns to identify what item failed.
Circle a letter from the right column to identify how item failed.

What Equipment?

PLUMBING
(1-19)

1. Urinal
2. Toilet
3. Water line
4. Valve
5. Faucet
6. Fuel line
7. Sewer
8. Steam
9. Storm
10. Natural Gas Line
11. Fire Sprinkler
12. Irrigation
13. Heater
14. Pump
15. Container

ELECTRICAL

(70-84)

70. Switch
71. Outlet
72. Panel
73. Fixture
74. Light (lamp)
75. Ballast
76. Battery
77. Wiring
78. Breaker
79. Conduit
80. Timer
81. Cords
82. Transformer (isol.)

100. Other____________
Specify

HVAC
(20-39)

20. Control
21. Thermostat
22. Filters
23. Duct
24. Refrigerant
25. Steam Trap

BUILDING TRADES
(40-69)

40. Door
41. Window
42. Hinge
43. Lock
44. Handle/Knob
45. Push/pull gate
46. Stops

47. **Glass**

48. Closures
49. Ceiling/floor tiles
50. Carpet
51. Partitions
52. Ext. Bldg.Struct.
53. Signs
54. Asphalt
55. Concrete
56. Fencing
57. Curbs
58. Shop equipment
59. Steps
60. Wall
61. Vehicle equip.

DISCREPANCY?

A Broken
B Burned out
C Damaged
D Disconnected
E Faulty Ground
F Flood
G Gas smell/leak
H Leak
I Loose
J Low level
K Low/No charge
L Missing
M No hot water
N No insulation
O No power
P Noisy
Q Out of adjustment
R Out of setting
S Overflow
T Plugged
U Smoke/odor
V Stuck open/closed
W Tripped
X Spill
Y Fell off
Z Programming
AA Contamination

AB Other__________
____
Specify

Figure 10-2. Equipment/Discrepancy Classification Form

10.5.2.6. Facility Condition Inspection. The Facility Condition Inspection is a part of the FCA process as discussed in paragraph 10.5, Continuous Inspections.

10.5.3. Inventory. The facilities and equipment inventory is the baseline for what is inspected and maintained. The inventory should permit identifying inspected items, items subject to PM inspection, and items subject to operator inspection. Chapter 3, Facilities Maintenance Management, discusses facilities and equipment inventories.

10.5.4. Frequency of Inspection

10.5.4.1. As the name implies, continuous inspections should be ongoing, with all facilities and equipment inspected periodically. The frequency of inspection depends on a number of factors, including the following:

a. Importance of the facility.

b. Legal or regulatory requirements.

c. Likelihood of condition changes since the last inspection.

d. Safety considerations.

e. Availability of inspection resources.

10.5.4.2. Table 10-1 provides suggested inspection intervals for a number of facilities and systems. These apply to facilities and equipment under average conditions supporting routine operations. Centers should adjust the frequencies to suit local conditions, regulatory requirements, known equipment conditions as a result of PM and PT&I, operational requirements, and user inputs.

10.5.5. Inspection Procedures. Preparing for and conducting an inspection involves many of the following steps, all of which may not apply in the case of PM Inspections and operator inspections:

a. Identifying the items to be inspected, based on the inventory.

b. Obtaining the facility or equipment history. This includes information on completed and pending work orders, as well as the results of past inspections and the current use of the facility or equipment.

c. Reviewing the applicable physical condition standards with a view toward the planned use of the facility or equipment. (Facilities or equipment scheduled for disposal or deactivation normally will have lower maintenance standards.)

d. Identifying planned changes to the configuration and use of the facility or equipment.

e. Identifying the inspector skills, specialized tools, and equipment required for the inspection.

f. Scheduling the inspection and setting the inspection route, considering the operational requirement for the facility, the availability of inspectors, and related factors. Factors such as safety certification requirements, mission criticality, observed rate of deterioration or condition change, and system availability determine inspection schedules and frequency.

Item Inspected	**Interval (years)**
Antenna-supporting Towers & Masts	2
Boilers and Water Heaters	1
Bridges	2
Building Structure	3
Building Electrical Systems	2
Bulk Fuel Storage	2
Cathodic Protection Systems	0.5
Chimneys and Stacks	2
Drainage and Erosion Control	1
Dredging, Moorings	3
Electrical Distribution Systems	1
Electrical Vaults, Manholes	2
Elevators, Lifts, and Dumbwaiters	1
Exhaust Systems	1
Explosive Storage Buildings	2
Explosive Building Grounding Systems	0.5
Fences, Walls	2
Fresh Water Storage	2
Fuel Facilities (Receiving and Issue)	1
Grounds	3
HVAC Systems	1
Inactive Buildings, Facilities	5
Pavements	1
Piers and Wharves, and Other Waterfront Structures	1
Plumbing	2
Power Switches, Instruments, Potheads	2
Railroads	1

Roofs	1
Sewage Collection and Treatment Systems	1
Steel Power Poles and Structures	3
Trusses	1
Water Treatment and Distribution Systems	1
Wood Poles	2

Table 10-1. Suggested Inspection Intervals Under Routine Operations and Average Conditions

g. Conducting the field inspection and documenting the conditions found. The documentation should be a clear and concise presentation of the conditions found and permit determining and estimating corrective action. (Serious and safety-related deficiencies should be entered into the work control system for immediate action.)

10.5.6. Inspection Followup. The following actions are normally taken with regard to deficiencies found during an inspection:

10.5.6.1. Reporting Conditions and Recommendations. Inspections are intended to be used for determining and initiating corrective action. Therefore, it is important that problems be reported and a recommended corrective action be submitted to cognizant facilities maintenance managers for decisions on corrective action. The following are a range of corrective actions:

a. Issuing work orders.

b. Expanding the types and increasing the frequencies of PT&I tests to allow for closer monitoring of the problem.

c. Including corrective action in the Annual Work Plan or 5-year Plan.

d. Preparing a facility project.

e. Modifying maintenance standards or actions.

f. Including the deficiency as part of the BMAR.

g. A combination of the above.

10.5.6.2. Estimating Corrective Actions. The cost estimate associated with an inspection report typically is a Scoping Estimate. However, repair work orders normally require a detailed estimate. All of the information obtained during the identifying and estimating process should be documented, including any impact on the customer. All information is then entered into the work control process for further determinations of prioritization, approval or deferral, and scheduling for accomplishment, as discussed in Chapter 5, Facilities Maintenance Execution.

10.6. Facilities Condition Assessment (FCA)

10.6.1. NASA Centers are responsible for identifying and quantifying facility conditions in order to support annual and 5-year Work Plans. The FCA is the method by which the Centers meet this obligation. Traditional methods of FCA have proven costly and historically have diverted money from needed maintenance. However, adoption of the RCM philosophy, PT&I, CMMS, and proactive maintenance approaches provide Centers with information related to facility condition that was not previously available. These new information sources, coupled with increased customer and user input, have the potential to provide valuable FCA data without having to perform many of the discrete inspections required under the traditional FCA processes. Any facility and equipment deficiencies identified in the FCA will be evaluated for failure and failure consequences (risk assessment) to identify safety impacts. When the evaluation identifies a safety impact (hazard to personnel or NASA property) the Center's safety office must be notified and appropriate action must be taken to alleviate the hazard. In addition to safety deficiencies, appropriate followup action should be taken to correct any of the other deficiencies identified.

10.6.2. Headquarters also requires adequate FCA information to ensure its proper stewardship over facilities entrusted to NASA, as well as to assist the Agency senior management and higher authorities (Congress, OMB) in projecting facilities budgetary needs relative to NASA's mission.

10.6.3. A third use of the FCA process is as a tool to evaluate contractor performance under a Performance-based Contract. While the FCA cannot address all aspects of the contractor's performance, it can be used to prognose the direction the Center is headed. For example, an increase in the number of equipment units in a PT&I alarm condition and/or an increase in the normalized TC rate should be leading indicators of a degrading condition for specific facilities, systems and equipment.

10.6.4. NPD 8831.1 requires that Centers continuously assess facility conditions to identify and quantify their BMAR so as to be 80-percent accurate at any point in time. This includes electrical, mechanical, and utility systems, buildings, roads, and grounds. FCA's are inspections and evaluation of data to ascertain condition only and do not include such maintenance actions as adjustments, lubrication, or repair. Since a Center's facilities are in a constant state of change due to normal wear and tear, renewal tasks, and reconfiguration, the FCA process must be dynamic if an accurate estimate of a Center's condition is to be obtained.

10.6.5. Following the general philosophy of maintaining reliable performance at the least cost, the FCA process should be more heavily weighted towards system function and customer (Facility User), than on age and appearance. Further, the process should not be labor intensive and should be at the least cost. To meet these requirements, Centers should utilize all of the inspection techniques listed in paragraph 10.5, Continuous Inspection, as appropriate along with their CMMS databases. Maintaining strict database management and accuracy is essential if a real time FCA process is to exist. The assessment should determine the condition or operational status of each item of equipment or facility as compared to a predetermined facilities condition baseline. Appropriate followup action should be taken to correct any deficiencies identified to include them in the AWP and to update the Center's BMAR and ROI records and the 5-year Plan.

10.6.6. Facility Classification. A consistent facilities-type classification process should be used that allows like facilities to be compared to one another statistically and financially. All facilities shall be classified into one of the following:

a. Office.

b. Research and Development (R&D) Facility.

c. Computer (Special Purpose) Facility.

d. Hangar/Aircraft Support.

e. Production Facility.

f. Non-Buildings (Trailers, temporary structures, air- or tension-supported facilities).

g. Laboratories.

h. Central Utility/Power Plant Facilities.

i. Utility Distribution Systems.

j. Roads and Grounds.

k. Other Miscellaneous Facilities.

10.6.7. Facility Criticality. Facility and infrastructure criticality is defined in terms of safety, impact on the mission, impact on the Center, and other categories listed in Table 10-2. Single points of failure - equipment that when fails, causes the entire system to fail - should also be considered.

CRITICALITY	CRITERIA
1	Environment, health, safety impact with a single point of failure.
2	Mission impact, single point of failure.
3	Environment, health, safety impact, multiple failures required.
4	Mission impact, multiple failures required.
5	Center impact (non-mission).
6	Significant economic consequences.
7	Employee morale.
8	Public relations.

Table 10-2. Criticality Selection Criteria

10.6.8. FCA Process Model. Figure 10-3 is a sample basic model for Center use in establishing a FCA program. CMMS data, statistical analysis, facility user, and Facility Manager input should be used in conjunction with the TC, PM, and PT&I databases.

10.6.9. FCA Analysis

10.6.9.1. Use of CMMS Data. The assessment should use CMMS data as an integrated part of its evaluation. The data can be analyzed statistically and searched for patterns or clusters that indicate changes in the condition of facilities and equipment. For maximum benefit to the FCA analysis, the CMMS should have data in the following fields:

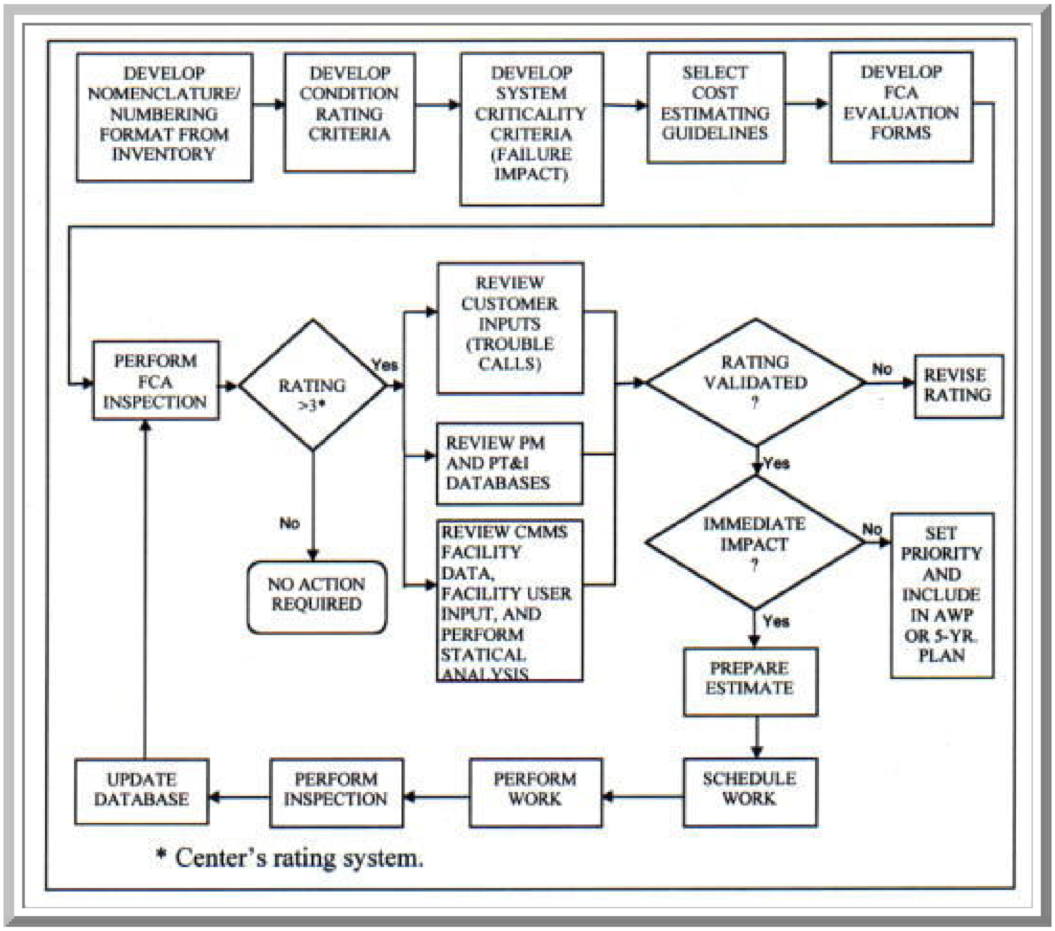

Figure 10-3. Sample FCA Process Model

a. Condition Codes.

b. Failure Codes.

c. Cost Data (labor and material).

d. Facility Type.

e. System Criticality.

f. Functionality.

g. Age of the Equipment.

h. Parts Availability.

i. Repair History.

j. Serviceability.

k. Energy Efficiency.

10.6.9.2. Statistical Analysis of CMMS Data. The data should be normalized by, among other things, the type of facility, square footage and the number of occupants, and the normal and standard deviations determined and trended over time. The trend line ideally should have a negative slope, indicating an improved condition.

10.6.9.3. Analysis of Energy Management and Control System (EMCS) Data. EMCS data should be analyzed as part of the FCA process to determine energy efficiency/ consumption changes that may indicate a deteriorating equipment or system condition (Appendix B, resource 7) that requires O&M action.

10.7. Maintenance Work Actions

Maintenance actions are the specific work tasks performed by the maintenance workers. These actions are the basis for work orders, workforce scheduling, and preparing budget estimates and work plans. Maintenance actions used in work orders are normally detailed, covering task specifics, while actions used for budgeting and long-range planning are more often generic or statistically derived.

10.8. Center Appearance and Grounds Care

10.8.1. Standards. Facilities design, colors, facades, and landscaping should fit in with other external architectural features, including signage, traffic flow, and visual and acoustic barriers. The resultant system should blend with local community standards and decor and properly represent NASA to the public. Where possible, the plan should emphasize low-maintenance features. Specific design guidelines are beyond the scope of this procedures guide. Facilities master plans often include landscaping plans, standards, and guidelines prepared by landscape architects. Landscape plans should include recommended maintenance actions. Facilities maintenance planning, including inspections and recurring maintenance, should ensure that facilities and grounds appearance represent NASA's best interests.

10.8.2. Grounds Care Guidelines. A large number of resources are available for obtaining guidelines for grounds care. These include Government publications, local agricultural extension services, trade and industry publications, and commercial grounds care services. Grounds maintenance plans should conform to the Center master plan and have the support and approval of senior Center managers. Grounds care frequently involves using controlled chemicals such as pesticides and herbicides, fertilizers, and other materials with potentially adverse environmental impacts. All work plans should include appropriate environmental and safety requirements.

10.8.2.1. Maintenance Levels

a. Based on land use, frequency of visitation, and visibility, Centers may wish to vary the quality (and cost) of grounds maintenance services specified for different parts of the Center. The following four levels are suggested:

(1) Level I - Administrative areas.

(2) Level II - Industrial, warehouse areas.

(3) Level III - Open storage, waterfront areas.

(4) Level IV - Railroad and power line rights-of-way.

b. Each maintenance level contains a distinctive mix of service requirements.

c. The service quality decreases as the maintenance level increases (e.g., grass cutting weekly in Level 1, every 2 weeks in Level II, monthly in Level III, and quarterly in Level IV (sufficient to reduce the fire hazard)).

10.8.2.2. Level of Service. There are three methods of specifying the level of Grounds care maintenance: frequencies, standards, and outcomes. Grounds care contract experience over many years at different locations has shown that specifying frequencies is preferable to specifying standards. Frequencies are easy to plan, schedule, enforce, and estimate costs. Grounds Care standards such as grass height or shrubbery appearance are difficult to estimate and enforce. Specifying outcomes, such as "lawns shall be green and well maintained at all times" is highly subjective and reliant on the contractor's proposed plan as part of the selection criteria, but is used with increasing frequency with outcome-based contracts.

10.8.2.3. Performance Requirements Summary. Grounds Care contracts should contain a performance requirements summary in simple tabular form. Table 10-3 is a sample of a performance requirements summary. Chapter 12, Contract Support, discusses grounds maintenance and other performance and outcome-type contracts in greater detail.

10.9. Maintenance Support Information (MSI)

a. Gathering MSI is a process of collecting life-cycle maintenance information on facilities and equipment. Table 10-4 is a list of typical MSI; all items listed may not apply in all cases. This table provides a basis for an MSI checklist.

b. Historically, collecting, documenting, organizing, and maintaining facilities and collateral equipment MSI has been difficult. Modern CMMSs can be used to perform most of these functions automatically.

Performance Indicator	Standard of Performance	MADR* Percent	Method of Surveillance	Percent of Cost
1.A CONTRACT REQUIREMENT: GRASS CUTTING, MAINTENANCE LEVEL I				
A. Grass cutting and trimming completed during specified periods and as scheduled.	Attachment J-C1, Contractor's approved schedule in SOW.	5	Planned sampling	15
B. Debris removed	Collected prior to cutting, removal from site, no clippings left on walks, streets, etc. (Paragraph ___ in SOW)	5	Planned sampling	15
C. Grass Cutting	Uniform height between __ and __ inches, clippings distributed (Paragraph ___ in SOW)	5	Planned sampling	20
D. Trimming	Matches height and appearance of surrounding mowed area (Paragraph ___ in SOW)	5	Planned sampling	20
1.B CONTRACT REQUIREMENT: EDGING, MAINTENANCE LEVEL I				
A. Edging completed during specified period(s) and as scheduled	Attachment J-C1, Contractor's approved schedule (Paragraph ___ in SOW)	5	Planned sampling	15
B. Quality edging	Clear zone [illegible] 1/2" [illegible] vegetat[illegible] from crac[illegible] (Paragraph ___ in SOW)	5	Planned sampling	15
C. Vegetation debris removed	Debris from edging removed off site same date (Paragraph ___ in SOW)	5	Planned sampling	15
1.C CONTRACT REQUIREMENT: PLANT AND SHRUB PRUNING, MAINTENANCE LEVEL I				
A. Pruning completed during specified period(s) and as scheduled	Attachment J-C1, Contractor's approved schedule (Paragraph ___ in the SOW)	10	Planned sampling	15

* MADR - Maximum Allowable Defect Rate

SAMPLE

Table 10-3. Sample Grounds Care Performance Requirements Summary

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Operating Instructions

- Safety Precautions
- Operator Prestart
- Startup, Shutdown, and Postshutdown Procedures
- Normal Operations

Emergency Operations
Operator Service Requirements
Environmental Conditions
Preventive Maintenance
Lubrication, Inspection, and Adjustment Data
PM Plan and Schedule
Predictive Testing & Inspection
Applicability and Methods (Technology)
PT&I Plan and Schedule
Repair
Troubleshooting Guides and Diagnostic Techniques
Wiring Diagrams and Control Diagrams
Maintenance (Including Overhaul) Procedures
Removal and Replacement Instructions
Spare Parts and Supply Lists
Repair Workhour Estimates
Proactive Maintenance
Equipment Family Breakdown History
Equipment/Facility Condition Trends
Equipment Tolerances and Process Parameters (Including Normal Temperature, Pressure, and Volume)
Other Data
Parts Identification
Warranty Information
Personnel Training Requirements
Testing Equipment and Special Tool Information
Calibration Data
Contractor/Vendor Information

Table 10-4. Typical Maintenance Support Information (MSI)

10.9.1. MSI Library

10.9.1.1. NASA facilities are aging, and there is a reduction in the frequency of replacement. Therefore, more attention must be given to maintaining existing facilities effectively and to collecting and recording MSI for those facilities. This requires a managed maintenance library system. Maintenance documentation becomes more valuable as facilities age. The library control procedures in the maintenance organization must ensure that MSI documents are identified, cataloged, and maintained so that they are available during the entire life-cycle of the facilities and equipment. All documents and records should be filed and retained in accordance with guidance provided in NPG 1441.1, Records Retention Schedules.

10.9.1.2. The MSI library can be dispersed if it is controlled and periodically inventoried. The library is most useful when it is readily available to the personnel who need the information and they can obtain it without undue effort. In the long term, this information should improve the effectiveness of the total maintenance operation. As MSI is incorporated into the CMMS, more of the maintenance personnel in the shop areas have access to the information, and necessary control is afforded by the CMMS itself.

10.9.1.3. MSI control is particularly important during the turnover of maintenance operations between contractors or from in-house to contractor operation. MSI that is considered unimportant during a transition period may become vital when an item of equipment starts to fail.

10.9.1.4. For new facilities and equipment, the vendor or construction contractor frequently provides MSI. However, it often is not in a form or in an amount sufficient to meet facilities maintenance needs. Further, manpower is not always available to develop facilities maintenance standards and procedures based on vendor- or contractor-provided information. Training provided by the contractor or vendor may or may not be adequate.

10.9.2. Policy

10.9.2.1. NPG 8820.2, Facility Project Implementation, makes provisions for obtaining MSI as part of the facilities project preparation and implementation process.

10.9.2.2. Paragraph 10.9.1, MSI Library, discusses the library and the need for having all existing MSI documents under library control. The following paragraphs address obtaining MSI for new facilities as part of the design process. Similar procedures can be used to obtain an A&E to gather information for existing facilities.

10.9.3. Planning

10.9.3.1. Identifying MSI should be an integral part of the planning process for new facilities. Its cost should be included in budget estimates for project design. MSI should be a deliverable prepared by the design A&E. MSI should be due when the facility is nearing completion, prior to beneficial occupancy. In this way, maintenance requirements should receive full consideration in the design process. This should result in a more easily maintained facility with full maintenance data and systems support at the time of occupancy.

10.9.3.2. Where the Center lacks adequate MSI for existing facilities, especially mission-critical facilities, use of an engineering services contract to gather MSI is recommended. This contract may be combined with a condition assessment or inventory contract or handled as a separate contract solely for MSI.

10.9.4. Procedures. While the management of A&E contracts may fall outside the responsibility of the facilities maintenance organization, the facilities maintenance organization should take an active role in developing MSI requirements. The following paragraphs describe a typical approach to the development of MSI and the organizations responsible for the necessary actions.

10.9.4.1. Center Responsibility. The Center is responsible for the following:

a. Determining whether a new or existing facility or equipment requires MSI and budgeting for the acquisition of MSI.

b. Including a requirement for MSI in an appropriate contract (i.e. in the A&E's design scope of work for a new facility as part of the scope of work for an engineering services contract for condition assessment or inventory or as the scope of work solely for MSI development. This includes determining the level of MSI detail, submission form, and formats required from the contractor.

10.9.4.2. Joint Center and Contractor Responsibility. The Center and the contractor should work together to identify items that require MSI.

10.9.4.3. Contractor Responsibility

a. The A&E contractor may be tasked to provide any or all of the following items:

(1) For new facilities or collateral equipment, specifying the MSI required from the construction, equipment installation, supply contractor, or equipment vendor.

(2) For existing facilities or collateral equipment, obtaining the information directly from the manufacturers or vendors of the existing facilities and equipment.

(3) Integrating the contractor-furnished information with the facility design features, and using the facility data (including Center operational requirements) to update the facility and equipment inventory and to document appropriate maintenance standards and procedures.

(4) Assembling the MSI into the required deliverable formats.

b. If any of these items are required, the requirements documents (and resultant contract) must reflect the project needs and deliverables accordingly.

10.9.5. Deliverables. The deliverables required by the MSI specifications may take several forms. In the past, hard copies of manuals, drawings, and maintenance procedures have been the most common. However, other formats are possible. Where automated inventory and maintenance management systems are in use, the MSI acquisition should include uploading the MSI into the CMMS. Deliverables should be in computer-readable formats, including Computer-Aided Design and Drafting (CADD), and GIS drawings. MSI specifications should call for linkages between drawings, drawing components, and CMMS databases where appropriate.

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